Structural changes in the Polish economy - the analysis of input-output

Olczyk, Magdalena
Gdańsk University of Technology

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Magdalena Olczyk
Katedra Nauk Ekonomicznych
Politechnika Gdańska, Wydział Zarządzania i Ekonomii
Ul. Traugutta 79
emial: Magdalena.Olczyk@zie.pg.gda.pl

STRUCTURAL CHANGES IN THE POLISH ECONOMY – THE ANALISIS OF INPUT-OUTPUT

Abstract

This paper analyses the structure of Polish economy using three input-output tables for years 1995, 2000 and 2004. Applying the traditional methods proposed by Rasmussen the sector's backward and forward linkages are identified. Industries with large backward and forward linkages are named "key sectors" and play an important role in the development strategy of a country, so the outcome of the paper may be used for the development strategy of Polish economy.
At the beginning of the article the idea of input-output table and Rasmussen's methodology of identifying the key sectors are discussed in detail. Then, based on three input-output tables, the key sectors in the Polish economy are selected and the role of these sectors over the years 1995-2004 is examined.

Key words: input-output tables, backward and forward linkages, key sectors.

Introduction

Among several key issues currently being discussed in Poland, the issue of structural changes is undoubtedly one of the most important. Process of transition of the Polish economy is connected with large structural changes among others in the consumption, the investments, the final demand and particularly in the process of production. Of course, since 1990 Polish sectors of production have been developing in different ways, with different speeds and they provide different opportunities for our economy. Now, it is very important to identify these sectors, which were crucial for Polish economy during twenty years of transformation. What is most needed, is the "sectoral route map", which could be very helpful for government to clearly indicate key sectors and accelerate their development.

The identification of the most valuable sectors in economy is based on the assumption that sectors of production don't exist in vacuum. Each economy consists of many inter-industry linkages among sectors. Each of these sector has different (weak or strong) connections with the other sectors. The size of a sector has in this case no significance. This is why *key sector* is defined as "a sector which, on one hand, is largely dependent on other industries, that is, it utilizes the products of other sectors in its production process, and on the other hand, other sec-

tors use its output as an intermediate product in their production processes. Investments in key sectors would thus initiate economic development due to the tight interrelations with other production sectors" (Temurshoev 2004).

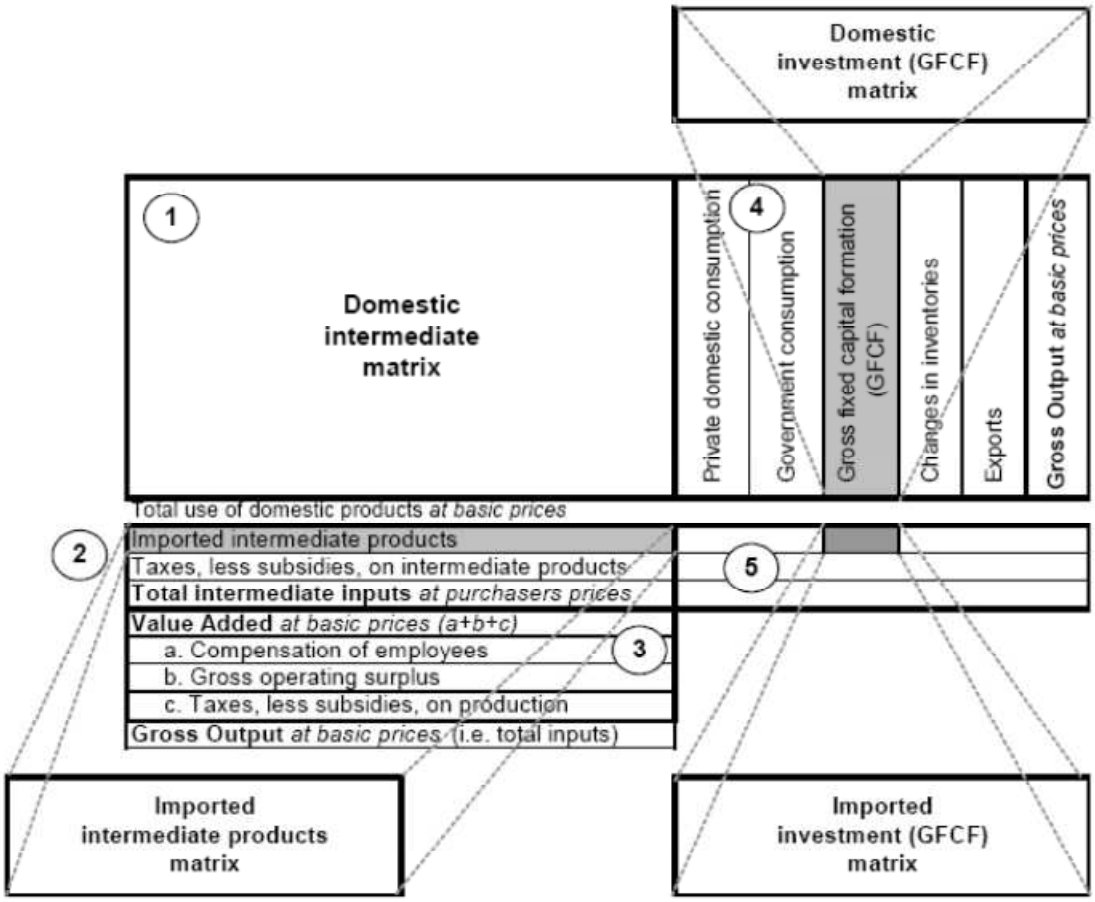
Analytical tool for identifying key sectors is the input-output table (discussed further below). The principle behind I/O analysis is simple: each industry produces to satisfy the final demand for its output but also the intermediate demands of all other sectors in the economy that use this output as a factor of production (input). So the production process in the economy involves a network of cross-sectoral linkages and the strength of these relationships is a criterion to indicate the most crucial sectors. There are two types of linkages, which measure the economic interdependences of sectors in terms of the magnitude transactions: backward and forward. Backward and forward linkages, which were first proposed by Rasmussen (1956), are calculated from the Leontief concept. The backward linkages based on the Leontief inverse matrix are defined as the column sums of the inverse matrix and measure the impact on supplier industries of a unit increase in final demand. Forward linkages, in turn, are defined as the row sums of the Leontief inverse matrix and they measure the effect on total output of all sectors associated with a unit change in the primary inputs of selected sector. The value of indicators used by Rasmussen (1956) for the assessment of such backward and forward linkages will allow indentify the most critical sectors in the Polish economy.

The structure of the paper is as follows. This introductory part, which deals with important issues to be addressed in this paper, is followed by a discussion on methodology and data. The author then takes a look at the results of the data analysis, followed by a concluding section that includes some policy recommendations as well.

The input-output analysis and key sectors of economy – theoretical aspects

Theoretical basis for the analysis of key sectors was founded by W. Leontief, an American scientist, Nobel laureate in economics in 1973. His analysis of the inputs and outputs, based on dependency of matrices among sectors in the economy, is also known as input-output analysis. For graphical presentation of his scientific analysis the classic structure of W. Leontief input-output table is shown in figure 1.

Figure 1. The structure of table "Input – Output".



Source: B.Wixted, N.Yamano, C.Webb : Input-output analysis in an increasingly globalised world. Application of OECD's harmonized internationals table, OECD working paper 2006/07, pp.8.

The first part of the table is a square matrix of transactions (called domestic intermediate matrix), presenting the interaction between national suppliers (grouped in rows) and customers (grouped in columns) that occur in production processes in the economy. Otherwise, this matrix presents the intermediate demand (production) in an economy that is sectoral spending on raw materials, supplies and services. Part of the table with the number 2, located below the matrix of transactions, includes in the rows the value of imports of intermediate goods and services and related subsidies mines taxes (net taxes). The sum of lines 1 and 2 are part of the table "input-output," giving us a total value of inputs (intermediate goods), in the purchase price. In the third part of the input-output table the value of each sector is added, informing at the same time about other costs of production. Value added is the sum of wages, surplus and gross operating taxes (less subsidies) associated with the production. The fourth part of classical "input-output" table, called the matrix of domestic investment, represents the final demand for particular products, or the part of the products which have been produced and not used in the production process as intermediate goods. The final demand consists of

(described in columns) private consumption, public consumption, export minus imports, investment and business expenses related to the change in inventories. It is worth remembering that the concept of "input-output analysis" based on the assumption that final demand is exogenous to the sectors of production i.e. it is not dependent on the level of production in these sectors.

The fifth and last part of the analyzed table is a matrix of import demand (called imported investment matrix), which contains a value of imported final goods with subsidies (less taxes) associated with those goods. The parts of number 4 and 5 of "input-output" table together constitute the total final demand in the economy in the purchase price. Already completed example input-output table is shown below.

Table 1. Example of input-output table.

	agriculture	**mining**	**manufactures**	**utilities**	**construction**	**services**	**private final consumption**	**government final consumption**	**GFCF**	**exports**	**Industry Output at basic prices**
agriculture	2731	3	8260	36	59	615	962	62	567	8568	21863
mining	4	282	2013	3979	188	60	28	0	210	5528	12292
utilities	3322	291	40218	480	8004	16999	16896	2340	8573	113777	210900
manufactures	983	53	2400	4395	85	3458	6184	14	439	238	18249
construction	121	70	565	135	14103	9509	405	530	33974	832	60244
services	2884	1078	28400	1404	9339	106994	126180	87409	16752	55512	435953
Imports	1779	1029	71117	1878	7572	33964	*24189*	*1085*	*17771*	81863	
Net taxes on productes	129	67	497	706	249	8651	*22908*	*-152*	*10233*	0	
TOTAL use at puchaser's prices	11953	2873	153470	13013	39599	180250	*197752*	*91288*	*88519*	266318	
Value Added at basic prices	9910	9419	57430	5236	20645	255703					
Industry Output at basic prices	21863	12291	210900	18249	60244	435953					

Source: B.Wixted, N.Yamano, C.Webb : Input-output analysis in an increasingly globalised world. Application of OECD's harmonized internationals table, OECD working paper 2006/07, pp.9.

Analysis of table 1 shows that the sum of all rows in a matrix of transactions and a matrix of investment illustrate the total demand for the production in the country and it amounts to 435 953 monetary units in the example shown. However, the sum of the columns of the matrix of transaction together with the matrix of value added and with the values of imports

of intermediate goods and services (part 2 table) show the total value of production in the economy. In our case, it also amounts to 435 953 , because the value of total consumption for each production sector (which incidentally is equal to the total demand for the production of the sector) must be equal to the value of output produced by this sector. Of course, this equality only occurs when the sum of final demand is equal to the value added and value of imports of intermediate goods and services.

Based on the above mentioned dependencies, W.Leontief writes the following balance equation:

$$X_i = \sum_{j=1}^{n} X_{ij} + Y_i \qquad i=1,\ldots..n \tag{1}$$

where:
x_i- total output of sector *i*
x_{ij}- intermediate input of sector *i* to sector *j*
y_i- final demand

Equation (1) can be written differently, if we enter the input coefficient (a_{ij}) into the equation. The term input coefficient refers to the quantity of inputs required from each industry to produce one zloty's worth of a given industry's output. [1] The sum of the elements in the *j* th columns of the input coefficients matrix is usually known as the **direct backward linkage.**

By replacing the $\sum_{j=1}^{n} x_{ij}$ in equation (1) by a_{ij} we obtain the following equation:

$$X_i = \sum_{j=1}^{n} a_{ij} X_j + Y_i \tag{2}$$

The equation (2) can be expresses in the matrix form X= AX+Y and re-written as

$$X = (I - A)^{-1} Y \tag{3}$$

where:

X is a column vector of total output X= [x_1 x_2……x_n]

Y is a column vector of final demand Y= [y_1 y_2….yn]

A is an (n x n) matrix of input coefficient a_{ij}

I is the (n x n) identity matrix.

The $(I-A)^{-1}$ is called the " Leontief inverse" or "total requirements" matrix and is used to find the main linkages in economy. Rasmussen (1956) uses the sum of columns of the "Leontief inverse matrix" to measure the both **direct and indirect backward linkage.** The

1 $b_{ij}= x_{ij}/x_j$

total backward linkages shows the total inputs requirements for a unit increase in the final demand for the j^{th} sector. It is defined as:

$$BL_j = \sum_{i=1}^{n} k_{ij} = B._j \tag{4}$$

where:

BL_j is the backward linkage of sector j of Rasmussen's method.

k_{ij} is the ij th element of Leontief inverse matrix

$B._j$ is the sum of column elements in sector j and n is the number of sectors.

The effects from supply-side of input-output model are called forward linkages. **The direct forward linkages** are defined as the sum of the rows of direct-input coefficients matrix and can be written as:

$$FL_i = \sum_{i=1}^{n} g_{ij} = F._i$$

FL_i is the forward linkage of sector *i* of Rasmussen's method.

g_{ij} is the ij th element of Leontief inverse matrix

$F._i$ is the sum of row elements in sector *i* and n is the number of sectors.

Rasmussen (1956) uses the sum of rows of the "Leontief inverse matrix" to measure the both **direct and indirect forward linkages.**

To inter-industry comparisons Rasmussen (1956) uses the backward indices called " Power of Dispersion Index" (5) and the forward indices called " Sensitivity of Dispersion Index"(6) They are defined as

$$U_j = \frac{\frac{1}{n} B.j}{\frac{1}{n*n} \sum_{j=1}^{n} B.j} \tag{5}$$

$$U_i = \frac{\frac{1}{n} F.i}{\frac{1}{n*n} \sum_{j=1}^{n} F.i} \tag{6}$$

The direct and indirect forward and backward linkages are the indices for identification the key sectors in an economy. Analysis of these indicators allows to identify sectors that as a "sellers" or "buyers" of semiproducts for intermediate consumption play the most important role in economy. If $U_i > 1$ it means that the unit growth in demand in all sectors will result in above-average growth in the sector *i* e.g. that products of sector *i* will be in greatest demand (above the average for all sectors). If $U_j > 1$ it means that the unit increase in the demand for

the products of sector *j* will cause an above-average growth in production throughout the economy.On the basis of these indicators, according to Rasmussen (1956), the key sectors will be identified. These sectors have strong ties to a "forward" and "backward" and their development involves the development of the whole economy.

The methods proposed by P. Rasmussen and A. Hirschman are the subject of frequent criticism. Mostly it relies on the argument that using these methods, links occurring in the economy are double counted. Because if first industry sells products to the second sector, then for the primary sector the forward link in the economy is listed and for the second sector the backward linkage is noticed. It also indicates, that forward and backward linkages, proposed by P.Rasmussen and A. Hirschamn are not weighted. Hence the proposition of B. Hazary, L. Jones and P. Laumasa take into account the relative role of each sector in meeting the final demand and in the formation the value added in economy. They propose for the calculation of backward linkage to use the weight of sector's share in final demand, while the weight uses to estimate the forward link is participation of the sector in the generation of value added throughout the economy.

P. Rasmussen's approach to the identification of key sectors is known in the literature as the traditional approach. To the newest methods to separate the most important sectors of the economy belong the primarily hypothetical extraction method of Miller and Lahr (called a hypothetical extraction method) and the method for an integrated approach with the matrix (called a matrix holistic approach). Currently, the most popular is the first one, involving the extraction of sequence analyzed sectors of the economy and the measurement of the effects of such operations in the percentage changes in production compared to the baseline scenario without extraction. The higher the percent of change, the more important sector of the economy. In view of some editorial limits, the author will use traditional methods for identifying key sectors in the Polish economy.

Backward and forward linkages in the Polish economy – the identification of key sectors – practical example.

The major data sources for the empirical part of the this paper come from input-output (IO) tables, downloaded from OECD database STAN. The author uses all (three) tables available for Polish economy domestic I/O for years 1995, 2000, 2004, in basic price. In the original I/O tables the Polish economy is divided into 48 sectors. For the purposes of transparency

and comparability all sectors are reclassified and aggregated into 27 single sectors (as shown in table 2).

Table 2. Reclassified sectors used in the study.

sector name	number	abbrevation
Agriculture, hunting, forestry and fishing	1	AG
Mining and quarrying	2	MI
Food products, beverages and tobacco	3	FO
Textiles, textile products, leather and footwear	4	TE
Wood and products of wood and cork	5	WO
Pulp, paper, paper products, printing and publishing	6	PU
Chemicals	7	CH
Non-metalic products	8	NO
Metal and metal products	9	ME
Non-electrical equipment	10	NN
Electrical equipment	11	EL
Transport equipment	12	TR
Other industrial product	13	OT
Production and distribution electricity	14	PR
Construction	15	CO
Trade	16	TD
Hotel and restaurant	17	HO
Transport	18	TS
Post and telecommunication	19	PO
Finance	20	FI
Real estate	21	RE
Renting machinery	22	RM
Computer	23	CM
R&D	24	RD
Education	25	ED
Health	26	HE
Other services	27	OS

Source: own description.

Firstly, author performs the descriptive analysis, to show what is the role of each individual sector in generating the total output and the total value added in Polish economy between 1995-2004. Analysis of table 3 shows that five sectors (out of 27) are responsible for generating almost 50% of value of total production in the Polish economy. In 1995 these sectors are trade, foods, agriculture, construction and real estate (49,8%), in year 2000 trade, food, construction, other services, agriculture (52,7%), whereas in 2004 to this group belong trade, food, other services, construction and transport sector (48,7%). Locomotives of the Polish economy, which determine the level of total production and which in each analyzed year are in TOP 5 of most productive sectors are: trade, food products, beverages and tobacco

and construction.

Table 3. Sectors with the highest share in total output in years: 1995, 2000, 2004.

no	sector	1995	sector	2000	sector	2004
1	Trade	12,4	Trade	15,8	Trade	14
2	Food products, beverages and tobacco	12,2	Food products, beverages and tobacco	10,9	Food products, beverages and tobacco	11,5
3	Agriculture, hunting, forestry and fishing	9,8	Construction	10,8	Other services	9,1
4	Construction	7,9	Other services	8,7	Construction	7,9
5	Real estate	7,5	Agriculture, hunting, forestry and fishing	6,5	Transport	6,2
6	Other services	6,5	Transport	4,8	Agriculture, hunting, forestry and fishing	5,8
7	Metal and metal products	5,5	Real estate	4,3	Metal and metal products	4,9
8	Chemicals	5,2	Production and distribution electricity	4	Real estate	4,7
9	Transport	5,1	Metal and metal products	3,9	Chemicals	4,5
10	Non-electrical equipment	4,5	Chemicals	3,5	Production and distribution electricity	4,2

Source: own calculation.

Between 1995-2004 large changes have occurred among the sectors that generate the highest value of production in the Polish economy (see table 4). Among the five most gaining the importance in generating the value of output are: the health sector, electrical equipment, finance, trade and transport sector. Unfortunately, for three of these sectors i.e. the other services, electrical equipment and finance sector is this growth the result of a low base i.e. the low position in year 1995. However, trade and transport sectors, consistently and gradually increase their share in total production in the Polish economy between 1995-2005.

Table 4. The sectors with the greatest rise and fall of shares in total production between 1995-2004 (in percentage points).

	Rise of share		Fall of shares
Other services	2,6	Agriculture	-4,2
Electrical equipment	2,3	Real estate	-2,8
Finance	1,8	Non-electrical equipment	-2,5
Trade	1,6	Textiles, textile products, leather and footwear	-1,4
Transport	1,1	Mining and quarrying	-1,3

Source: own calculation.

In turn, the sectors that record the strongest (in percentage points) drop in its share in total

value of output in the Polish economy are agriculture, real estate, non-electrical equipment, textiles and mining sector. These decreases indicate permanent structural changes in the sectors, which determine the value of production in Poland. It is worth to notice the significant decline in the role of agricultural and mining sectors in the growth of Polish economy.

Next the author analyzes the positions of individual sectors in the generation of value added in the Polish economy and its changes between 1995-2004 (see table 5).

Table 5. Sectors with the highest share in value added in years: 1995, 2000, 2004.

no	sector	1995	sector	2000	sector	2004
1	Trade	18,5	Trade	18,7	Trade	20,5
2	Other services	10,5	Other services	17	Other services	12,5
3	Agriculture, hunting, forestry and fishing	7,7	Construction	7,4	Construction	6,5
4	Construction	6,3	Real estate	6,5	Transport	4,7
5	Real estate	5,2	Transport	4,8	Education	4,5
6	Education	4,4	Education	4,6	Production and distribution electricity	4
7	Production and distribution electricity	4,3	Health	4	Health	3,9
8	Non-electrical equipment	4,2	Agriculture, hunting, forestry and fishing	3,5	Real estate	3,7
9	Health	4,1	Food products, beverages and tobacco	3,3	Agriculture, hunting, forestry and fishing	3,6
10	Food products, beverages and tobacco	4,1	Production and distribution electricity	3,1	Non-metalic products	3,5

Source: own calculation.

In this analysis, the similar concentration as among the sectors with the highest share of total added value is observed. Five of 27 sectors in the Polish economy generates nearly half its added value in Polish economy. The analysis of table 5 shows that in year 1995 these sectors are: trade, other services, agriculture, construction and real estate (48, 2%), in year 2000 trade, other services, construction, real estate, transport (54,4%), whereas in 2004 to this group belong trade, other services, construction and education sector (48,7%).

Trade sector is the undisputed leader both in terms of share of this sector in the generation the value added as well as in terms of its role in the growth of Polish economy. This sector occupies first place in all years analyzed, having in each of these years the highest share in generating the value added as well as in the total output of Polish economy. It should also stress the importance of the construction sector and other services sector in the creation of value added in the Polish economy. In all examined years, they belong to the TOP 5 of the sectors with largest contribution in the generation of added value.

When considering the participation of analyzed sectors in the creation of value added in the Polish economy, it is worth emphasizing significant changes in the role of particular sectors between the years 1995-2004 (see table 6).

Table 6. The sectors with the greatest rise and fall of shares in total value added between 1995-2004 (in percentage points).

	wzrost udziałów		spadek udziałów
Electrical equipment	2,6	Agriculture, hunting, forestry and fishing	-4,1
Trade	2	Non-electrical equipment	-1,8
Finance	1,8	Real estate	-1,5
Other services	1,7	Mining and quarrying	-0,9
Non-metalic products	0,8	Textiles, textile products, leather and footwear	-0,9

Source: own calculation.

To the five sectors, which shares in the generation of added value between 1995-2004 mostly increased belong: electrical equipment, trade, finance, other services and a sector of non-metallic products**.** Among them, especially in trade and in finance sectors this increasing trend is clearly observed in the years 1995-2004**.** In turn, the sectors that record the strongest (in percentage points) drop in its shares in total added value in the Polish economy are agriculture, non-electrical equipment, real estate, mining and textiles sector. These decreases indicate permanent structural changes in the sectors, which determine the total value added in Poland. It is also worth to notice, that the same five sectors (agriculture, non-electrical equipment, real estate, mining, textiles) lose mostly their significance both in the growth of Polish economy (measured by drop in its share in total value of output) and in generation of the total added value between 1995-2004.

The next step in this analysis is to calculate and analyze the direct links between the sectors in the Polish economy. It is worth to mention that the first attempts to supply quantitative evaluation of backward and forward linkage were made by Chenery and Watanabe in their analyses on the international study of the structure of production.

In table 7 the direct backward and direct forward linkages in Polish economy are presented. There are ten sectors (the same throughout the period considered) with the strongest backward linkages in Poland. These sectors are: agriculture, food and beverages products, wood and products of wood, pulp and paper production, non-metalic products, metal and metal products, transport equipment, other industrial products, construction, transport. In turn, seven sectors belong to group of sectors with the largest forward linkages throughout the period analyzed i.e.: agriculture, chemicals, metal and metal products, production and distribution

electricity, trade, post and telecommunication and the sector of other services.

Table 7. Direct backward and forward linkages.

		direct backward linkages				direct forward linkages		
		1995	2000	2004		1995	2000	2004
1	Agriculture, hunting, forestry and fishing	0,544	0,600	0,450	1	0,881	0,648	0,572
2	Mining and quarrying	0,376	0,339	0,271	2	0,532	0,421	0,319
3	Food products, beverages and tobacco	0,700	0,687	0,684	3	0,367	0,541	0,493
4	Textiles, textile products, leather and foot-wear	0,470	0,370	0,370	4	0,355	0,122	0,111
5	Wood and products of wood and cork	0,549	0,503	0,540	5	0,249	0,311	0,289
6	Pulp, paper, paper products, printing and publishing	0,508	0,427	0,490	6	0,500	0,355	0,364
7	Chemicals	0,525	0,363	0,410	7	0,725	0,604	0,608
8	Non-metalic products	0,479	0,463	0,462	8	0,498	0,484	0,496
9	Metal and metal products	0,600	0,496	0,489	9	0,612	0,624	0,599
10	Non-electrical equipment	0,474	0,419	0,444	10	0,529	0,249	0,151
11	Electrical equipment	0,013	0,442	0,413	11	0,003	0,233	0,217
12	Transport equipment	0,002	0,582	0,487	12	0,109	0,251	0,163
13	Other industrial product	0,473	0,521	0,518	13	0,253	0,155	0,168
14	Production and distribution electricity	0,489	0,489	0,451	14	0,708	0,788	0,721
15	Construction	0,530	0,521	0,480	15	0,257	0,551	0,499
16	Trade	0,408	0,420	0,368	16	1,571	1,837	1,780
17	Hotel and restaurant	0,527	0,587	0,450	17	0,108	0,088	0,073
18	Transport	0,490	0,432	0,482	18	0,605	0,543	0,570
19	Post and telecommunication	0,381	0,467	0,352	19	0,316	0,415	0,366
20	Finance	0,611	0,482	0,374	20	0,256	0,538	0,482
21	Real estate	0,586	0,369	0,370	21	0,901	0,204	0,256
22	Renting machinery	0,001	0,182	0,308	22	0,003	0,064	0,078
23	Computer	0,099	0,355	0,320	23	0,003	0,122	0,187
24	R&D	0,000	0,322	0,384	24	0,003	0,107	0,182
25	Education	0,181	0,153	0,156	25	0,017	0,033	0,036
26	Health	0,283	0,242	0,249	26	0,048	0,068	0,080
27	Other services	0,385	0,310	0,327	27	0,161	1,185	1,241

Source: own calculation.

What is important, up to 21 out of 27 surveyed sectors are characterized in 2004 by a weaker direct backward linkages in comparison to 1995. In particular, this trend is evident in the agricultural and financial sector. However, the group of six sectors, in which an increase of the index of direct backward is observed, consists of sectors such as: electrical equipment, transport and other industrial products, renting machinery, computer and R & D. These increases, however, are in all sector connected with the effect of low base.

In turn, according to the direct forward linkages, only in 12 sector devaluations of direct forward linkages are observed. They are most strongly evident in agriculture, non-electrical equipment and real estate sectors. However, among the 15 sectors, in which the forward lin-

kages with another sectors are strengthened during years analyzed, in three of them a strong increasing tendency are noticed. They are: an electrical equipment sector, a construction and a trade sector. Among all sector a trade sector in all years analyzed is characterized by a four times greater value of direct forward linkages than mean value for all sectors.

Next, total (direct and indirect) backward and forward linkages for Poland in years 1995,2000, 2005 are calculated (table 8).

Table 8. Direct and indirect forward and backward linkages.

		direct and indirect backward linkages				direct and indirect forward linkages		
		1995	2000	2004		1995	2000	2004
1	Agriculture, hunting, forestry and fishing	2,109	2,200	1,812	1	2,707	2,313	2,048
2	Mining and quarrying	1,730	1,597	1,464	2	2,165	1,866	1,632
3	Food products, beverages and tobacco	2,495	2,410	2,261	3	1,725	1,971	1,828
4	Textiles, textile products, leather and footwear	1,915	1,640	1,623	4	1,588	1,177	1,152
5	Wood and products of wood and cork	2,108	1,946	1,970	5	1,396	1,461	1,419
6	Pulp, paper, paper products, printing and publishing	2,009	1,739	1,841	6	1,946	1,632	1,624
7	Chemicals	2,039	1,633	1,684	7	2,482	2,114	2,097
8	Non-metalic products	1,933	1,818	1,795	8	1,965	1,882	1,864
9	Metal and metal products	2,175	1,892	1,847	9	2,250	2,064	1,981
10	Non-electrical equipment	1,930	1,749	1,763	10	2,079	1,436	1,238
11	Electrical equipment	1,037	1,787	1,709	11	1,006	1,397	1,334
12	Transport equipment	1,037	2,063	1,835	12	1,236	1,394	1,249
13	Other industrial product	1,938	1,955	1,921	13	1,467	1,254	1,256
14	Production and distribution electricity	1,919	1,844	1,733	14	2,457	2,363	2,195
15	Construction	2,052	1,955	1,848	15	1,515	2,066	1,922
16	Trade	1,814	1,754	1,635	16	3,993	4,332	4,075
17	Hotel and restaurant	2,023	2,176	1,858	17	1,181	1,164	1,130
18	Transport	1,904	1,771	1,831	18	2,295	2,113	2,121
19	Post and telecommunication	1,718	1,790	1,568	19	1,539	1,765	1,655
20	Finance	2,232	1,886	1,613	20	1,412	2,047	1,837
21	Real estate	2,191	1,664	1,635	21	3,062	1,390	1,461
22	Renting machinery	1,109	1,320	1,508	22	1,006	1,109	1,121
23	Computer	1,121	1,600	1,511	23	1,278	1,188	1,288
24	R&D	1,306	1,551	1,640	24	1,390	1,142	1,253
25	Education	1,346	1,265	1,262	25	1,032	1,047	1,052
26	Health	1,561	1,413	1,405	26	1,083	1,092	1,106
27	Other services	1,735	1,543	1,549	27	1,275	3,181	3,184

Source: own calculation.

To identify " key sector" the author takes into account the value of both indices e.g indices of backward (BL) and forward linkages (FL). If a sector has the value of backward and forward linkage greater than one, it means that this sector has a greater impact on the suppliers of the inputs and that simultaneously it (as a supplier) has greater impact on the producers. After the selection of key sectors, the decisive criterion for the importance among key sectors

are the value of BL and FL indices. The key sectors with highest value are ranked (see table 9). Based on the values of the ranks of the indices obtained, it is found that the number of key sector between 1995-2004 decreased from 10 in 1995 to 6 in the 2000 and 2004.

The most important key sector in the Polish economy is the sector of food products, beverages and tobacco (ranked second in 2000 and first in 2004). Its strong position is a result of being a main supplier for other sectors. In analyzed period the transport sector gained the most, because it was ranked seventh in 1995 and second in 2004

Table 9. Power of dispersion and sensitivity of dispersion.

		1995			2000			2004		
Sector name	**no**	**U_j**	**U_i**	**Rank**	**U_j**	**U_i**	**Rank**	**U_j**	**U_i**	**Rank**
Agriculture, hunting, forestry and fishing	1	1,189	1,53	**3**	1,302	1,239	**1**	1,2	1,061	**4**
Mining and quarrying	2	0,976	1,22		1,051	0,899		0,96	0,857	
Food products, beverages and tobacco	3	1,407	0,97		1,11	1,357	**2**	1,07	1,324	**1**
Textiles, textile products, leather and footwear	4	1,080	0,9		0,662	0,923		0,67	0,95	
Wood and products of wood and cork	5	1,189	0,79		0,823	1,096		0,83	1,153	
Pulp, paper, paper products, printing and publishing	6	1,133	1,1	**9**	0,919	0,979		0,95	1,078	
Chemicals	7	1,150	1,4	**4**	1,19	0,919		1,23	0,986	
Non-metalic products	8	1,090	1,11	**10**	1,059	1,024		1,09	1,051	
Metal and metal products	9	1,226	1,27	**5**	1,162	1,065	**5**	1,16	1,081	**5**
Non-electrical equipment	10	1,088	1,17	**8**	0,808	0,985		0,72	1,032	
Electrical equipment	11	0,564	0,57		0,787	1,006		0,78	1	
Transport equipment	12	0,564	0,7		0,785	1,161		0,73	1,074	
Other industrial product	13	1,093	0,83		0,706	1,101		0,74	1,125	
Production and distribution electricity	14	1,082	1,39	**6**	1,33	1,038	**3**	1,29	1,015	**3**
Construction	15	1,157	0,85		1,163	1,101	**4**	1,13	1,082	**6**
Trade	16	1,023	2,25	**1**	2,439	0,987		2,39	0,957	
Hotel and restaurant	17	1,141	0,67		0,655	1,225		0,66	1,087	
Transport	18	1,074	1,29	**7**	1,189	0,997		1,24	1,072	**2**
Post and telecommunication	19	0,969	0,87		0,993	1,008		0,97	0,918	
Finance	20	1,259	0,8		1,152	1,062	**6**	1,08	0,944	
Real estate	21	1,235	1,73	**2**	0,783	0,937		0,86	0,957	
Renting machinery	22	0,564	0,57		0,624	0,743		0,66	0,883	
Computer	23	0,564	0,57		0,669	0,901		0,75	0,885	
R&D	24	0,978	0,57		0,643	0,873		0,73	0,96	
Education	25	0,564	0,58		0,59	0,712		0,62	0,739	
Health	26	0,880	0,61		0,615	0,795		0,65	0,822	
Other services	27	0,978	0,72		1,791	0,869		1,86	0,907	

Source: own calculation.

The strength of this sector is connected with a high dependency on transport services in our economy. Four sectors namely agriculture, metal, production of electricity and construction belong, during all period, to the TOP 6 of Polish key sectors due to a great impact on the suppliers of inputs. In table 9 the normalized values of backward and forward linkages of i.e. the power of dispersion and sensitivity of dispersion are shown

Summary

The aim of this paper is to find better understanding of the pattern of structural changes in industries and identify key sectors in Polish economy. To reach the details structural changes the author applied a simple method, based on input-output framework.

Firstly, author performs the descriptive analysis, to show what is the role of each individual sector in generating the total output and the total value added in Polish economy between 1995-2004. Locomotives of the Polish economy, which determine the level of total production and which in each analyzed year are in TOP 5 of most productive sectors are: trade, food products, beverages & tobacco and construction sector. The similar concentration among the sectors with the highest share of total added value in our economy is observed. Five of 27 sectors generates nearly half its added value in Polish economy in each year analyzed. Three of this five are most important i.e.: a trade sector, other services and construction.

Trade sector is the undisputed leader both in terms of share of this sector in the generation the value added as well as in terms of its role in the growth of Polish economy. This sector occupies first place in all years analyzed, having in each of these years the highest share in generating the value added as well as in the total output. On the other hand, the agriculture is unluckily the leader of strongest (in percentage points) drop in it shares in total added value and in the total growth of the Polish economy.

Moreover, the results of analysis based on backward and forward linkages (direct and total linkages) allows to confirm the hypothesis about small structural changes in our economy. Consistently, the same group of ten sectors has the strongest forward linkages in years 1995, 2000, 2004, with the agriculture's sector as the leader. Thus the agriculture, although it loses its position in generating the economic growth in Poland and also in creating the added value in the Polish economy, still this sector is strongly linked with other sectors**.**

Also the role of six sectors, having the greatest impact of economy as suppliers in three analyzed years, have changed little. Among these sectors with largest backward linkages, food and beverage production and the sector of transport are most important.

The sector with both highest value of backward and forward linkages is identified as a key, so in the last part of analysis the author tries to find the key sectors in Polish economy. First of all it is observed that the number of key sector between 1995-2004 decreased from 10 in 1995 to 6 in the 2000 and 2004. At the end of the period analyzed to the group of the most important sector in Polish economy belong: food products, beverages and tobacco (the leader); transport; production and distribution electricity; agriculture, hunting, forestry and fishing; metal and metal products and construction sector. Surprisingly, the trade sector is not qualified for the group of key sectors in 2000 and 2004, although in 1995 the sector has been a leader in the ranking of key sectors.

Comprehension check.

1.Describe the assumptions and the concept of input-output analysis.

2.Discuss the differences between forward and backward linkages in the economy.

3.Describe the methodology of key sector's identification, proposed by P. Rasmussen.

Recommended readings.

1. Leontief W., Quantitative Input-Output Relations in the Economic System of the United States, Review of Economics and Statistics, no 3, August 1936.

2. Leontief W, Input . Output Economics. Second ed., Oxford University Press, New York, 1986.

3. Rasmussen P.N., Studies in inter-sectoral Relations, North-Holland Publishing Company, Amsterdam, 1956.

REFERENCES:

1. Andreosso-O'Callaghan B., Yue G., (2004), Intersectoral Linkages and Key Sectors in China, 1987-1997, Asian Economic Journal, no 18 (2), pp.165-183.
2. Aydin H., (2007), An Analysis of Input-Output Inter Industry Linkages in the Turkish Economy, Papers of the 16th International Input-Output Conference, Istanbul.
3. Bulmer-Thomas V., Input-Output Analysis in Developing Countries, John Wiley & Sons Ltd., 1982.
4. Bon R., (1986), Comparative stability analysis of deman-side and supply-side input-output models, International Journal of Forecasting, vol.2, no.2, pp.231-236
5. Cella G., (1984), The Input-Output Measurement of Interindustry Linkages, Oxford Bulletin of Economics and Statistics, no 46 (1), pp.73-84.
6. Chenery H., Watanabe T., International comparison of the structure of production, Econometrica, vol. XXVI, no.26, pp.73-83.

7. Claus I., Inter industry linkages in New Zealand, New Zealand Treasury Working Paper 02/09, 2002.
8. Department of Statistics, Poland, (1995), Polish Input-Output Tables 1995.
9. Department of Statistics, Poland, (2000), Polish Input-Output Tables 2000.
10. Department of Statistics, Poland, (2004), Polish Input-Output Tables 2004.
11. Dietzenbacher E (2002), Interregional Multipliers: Looking Backward, Looking Forward, Regional Studies, vol.36, no.2, pp.125-136.
12. Dietzenbacher E., van der Linden J.A, (1997), Sectoral and Spatial Linkages in the EC Production Structure, Journal of Regional Science, no. 37, pp. 235-257.
13. Ghosh A.,(1958), Input-Output Approach in an Allocative System. Economica, no 25, pp.58-64.
14. Hazari B. (1970), Empirical indentification of key sector in the Indian economy, Review of Economics and Statistics, vol.52, no 3, pp.301-305.
15. Leontief W., Quantitative Input-Output Relations in the Economic System of the United States, Review of Economics and Statistics, no 3, August 1936, pp. 105-125.
16. Leontief W, Essays in Economics. Theories, theorizing, facts, and policies. New Brunswick and Oxford, 1985.
17. Leontief W, Input . Output Economics. Second ed., Oxford University Press, New York, 1986.
18. Laumas P., (1975), Key sectors in some undeveloped countries., KYKLOS, no. 28, pp.62-79.
19. Laumas P., (1976), Key sector in some underdeveloped countries: A replay, KYKLOS, vo.29, no 4, pp.767-769.
20. McGilvray J., (1977), Linkages, key sectors and development stategy, Cambridge University Press, Cambridge.
21. Miller R., Blair P.D, Input-Output Analysis, Prentice-Hall, 1985.
22. Rasmussen P.N., Studies in Inter-sectoral Relations, North-Holland Publishing Company, Amsterdam, 1956.
23. Robles L., Sanjuan J., Comparative analysis of input-output tables in time, Estadistica Espanola, vol. 47, no 158, pp.143-177.
24. Rose A., Chen Ch.,(1991), The join stability of Input Output production and allocations coefficients, Advances in Input-Output Analysis: Technology, Planning and Development, New York, Oxford University Press.
25. Schultz S, (1977), Approaches to Identifying Key Sectors Empirically by Means of Input-Output Analysis, Journal of Development Studies, no. 14, pp.77-96.
26. Sonis M., Guilhoto, J.J.M., Hewings, G.J.D Martins, E.B., (1995), Linkages, Key Sectors, and Structural Change: Some New Perspective, The Developing Economies, XXXIII (3), pp. 233-270.
27. Sonis M., Geoffrey J., Hewings M., Guo J. (2000), A New image of classical Key Sector Analysis: Minnimum Information Decomposition of the Leontief Inverse, Economic System Research, vol.12, no 3, pp.401-423.
28. Strassert G., (1968), .Zur Bestimmung strategischer Sektoren mit Hilfe von Input-Output-Modellen, Jahrbucher fur nationalokonomie und Statistik, no182, pp. 211-215.
29. Temurshoev U., (2004), Key Sectors in the Kyrgyzstan Economy, Discussion Paper No. 2004-135, Charles University.
30. Verspagen B., (2002), Structural change and technology, A long view, Eindhoven Centre of Innovation Studies- Working paper 02.13, Eindhoven University of Technology, Eindhoven.
31. Wixted B., Yamano N.,Webb C., (2006),Input-output analysis in an increasingly globalised world, Application of OECD's harmonized internationals table, OECD working paper

no 7, pp.8.